Table of Contents

Instrument Cluster Electronics

Initial Print Date: 12/04 Revision Date:

Instrument Cluster Electronics (IKE)

Model: E38, E39, E53

Production: All from start of production.

OBJECTIVES

After completion of this module you will be able to:

- Understand IKE operation
- Recognize production changes to IKE
- Understand IKE gateway function
- Understand inputs and outputs of the IKE
- Understand how redundant data is stored.

Purpose of the System

The instrument cluster is the main driver information display unit. The instrument cluster is made up of the IKE and a display unit. This type of cluster is known as the "high version".

The "high version" cluster is used on the E38 as a standard feature and the E39 and E53 as an option.

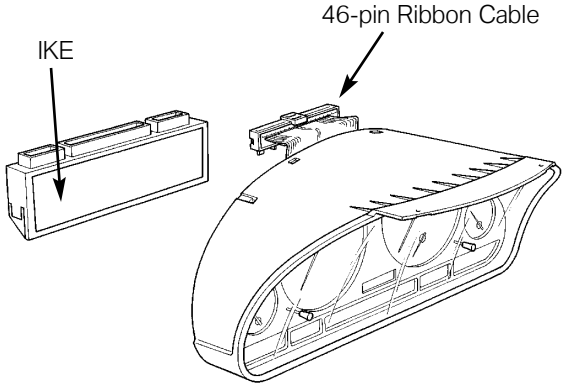
The instrument cluster incorporates the five familiar analog gauges along with indicator lights, warning lights and Liquid Crystal Displays.

When introduced, the IKE was mounted externally on the cluster and was replaced as a separate part. The IKE was connected to the cluster via a 46-pin ribbon cable. The external IKE was eliminated in vehicles from 9/97 and the IKE is now integrated into the cluster housing. If the early version requires replacement the integrated IKE will replace the earlier version.

The IKE functions as a gateway between the D, I and K-Busses. The CAN bus was also added from 9/97.

The IKE contains all of the processing electronics for the Instrument Cluster and On-Board Computer. The Instrument Cluster is merely a display unit and performs no processing. On Board Computer data can be displayed in the MID or the matrix display in the cluster.

There is also an EEPROM in the IKE for storage of the Central Coding Key (ZCS).



High Cluster Early Version to 9/97

Components

Although there a no serviceable parts in the instrument cluster (except bulbs), there are numerous features which make up the instrument cluster. Currently, the IKE is integrated into the cluster housing and none of the gauges or LCD displays are replaceable. When the cluster or IKE needs replacement, the entire cluster must be replaced.

Indicator Lamps

All the indicator/warning lights are LEDs and not replaceable. Critical warning indicators use two LEDs for a safety margin. There are five conventional bulbs for the back lighting of the LCD which can be replaced if necessary.

LC Displays

The LC displays are in the lower portion of the instrument cluster. They displays are used to make the driver aware of important information such as check control messages, service intervals, outside temperature, transmission range etc.
The LCD provides:

- 6 digit total mileage
- 4 digit trip mileage
- Manipulation DOT
- Outside temperature display
- 20 digit read-out with reminder arrows
- Service Interval Indicator
- Automatic transmission selector position
- Automatic transmission driving program

When KLR is switched on, mileage and temperature are displayed. All displays are illuminated from KL15. The back lighting intensity of the LCD's is dependent on available light and is controlled by a photo-transistor in the lower left corner of the cluster. When the parking lights are switched on, the dash mounted dimmer wheel controls the intensity of the back lighting.

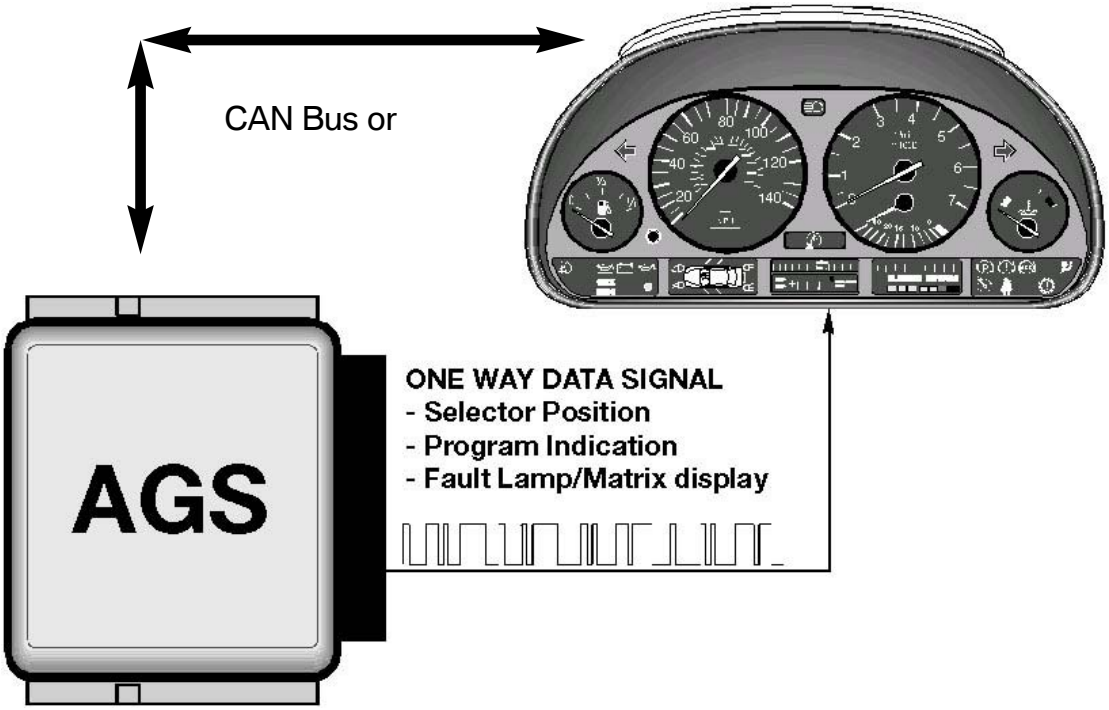
Service Interval Indicator (SIA)

The Service Interval Indicator up to 96 models uses the SIA II processing as in the past models. The models from 96 uses the SIA III processing which uses the miles traveled and the "ti" signal to calculate service intervals. The reset of Service Indicator is carried out with the reset tool on early models up to 9/00. Later models (from 9/00) are reset through the instrument cluster test functions (reset mode).

Total Mileage/Trip Mileage
Mileage can be displayed with the key off for 25 seconds if the trip meter button is pressed.
Total mileage is stored in non-volatile memories of the IKE and LM to protect against loss.

Automatic Transmission Selector Position/Driving Program
Up to 9/97- The selector lever position and driving program are signaled to the IKE from the EGS control module over a single wire circuit. The only driving program indicator in the cluster on US/CDN cars will be the "M".

From 9/97- The selector lever position and driving program are sent from the EGS control module to the IKE via the CAN-Bus.



Analog Instruments

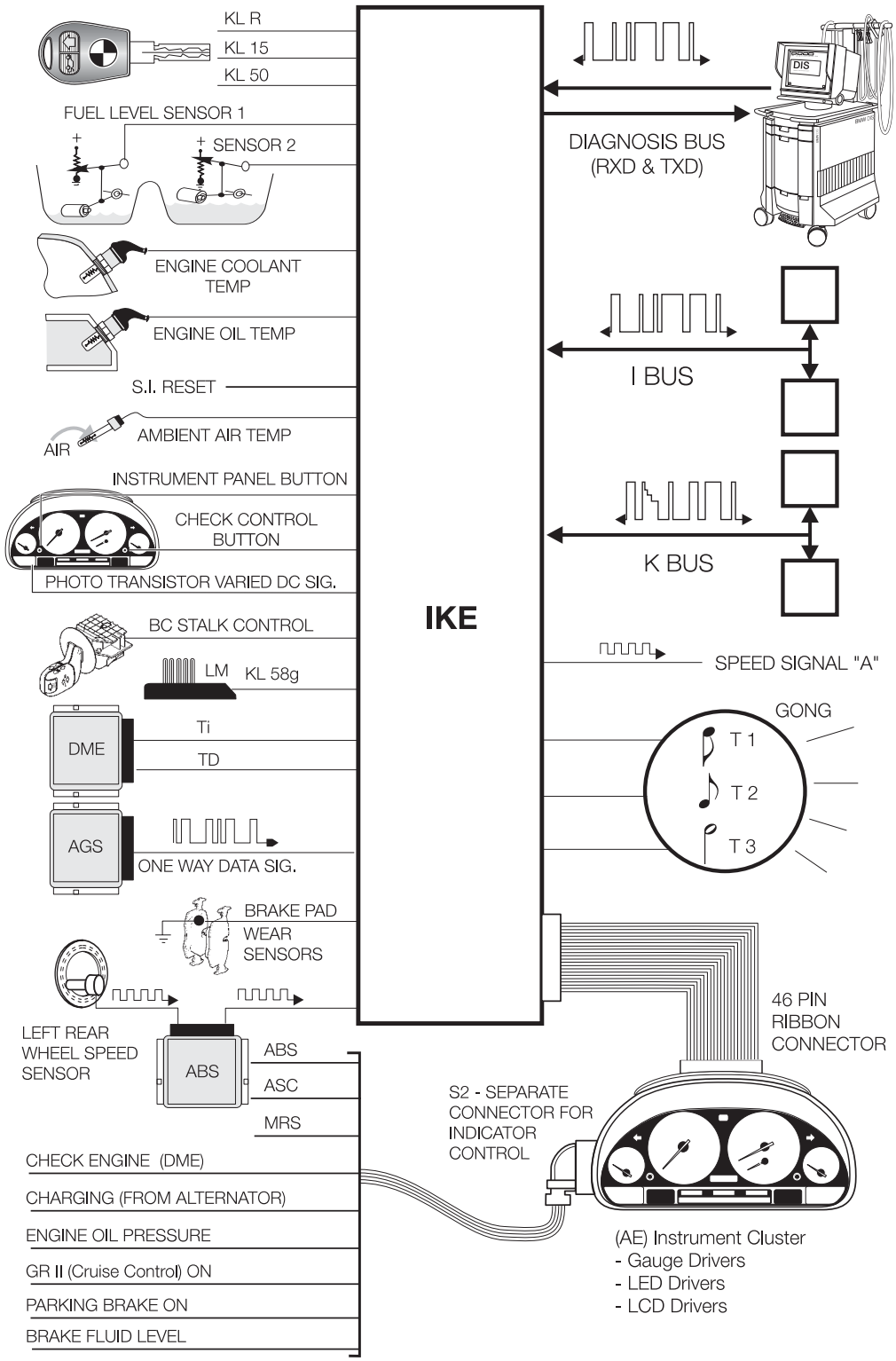
Analog instruments are controlled by the IKE from signals it receives over separate inputs or by data received on the CAN-Bus.

The needle of the coolant temperature gauge is centered if coolant temperature is between 75°C- 110°C. Early models received temperature signals from a dual NTC sensor. Later models obtained coolant temperature from CAN.

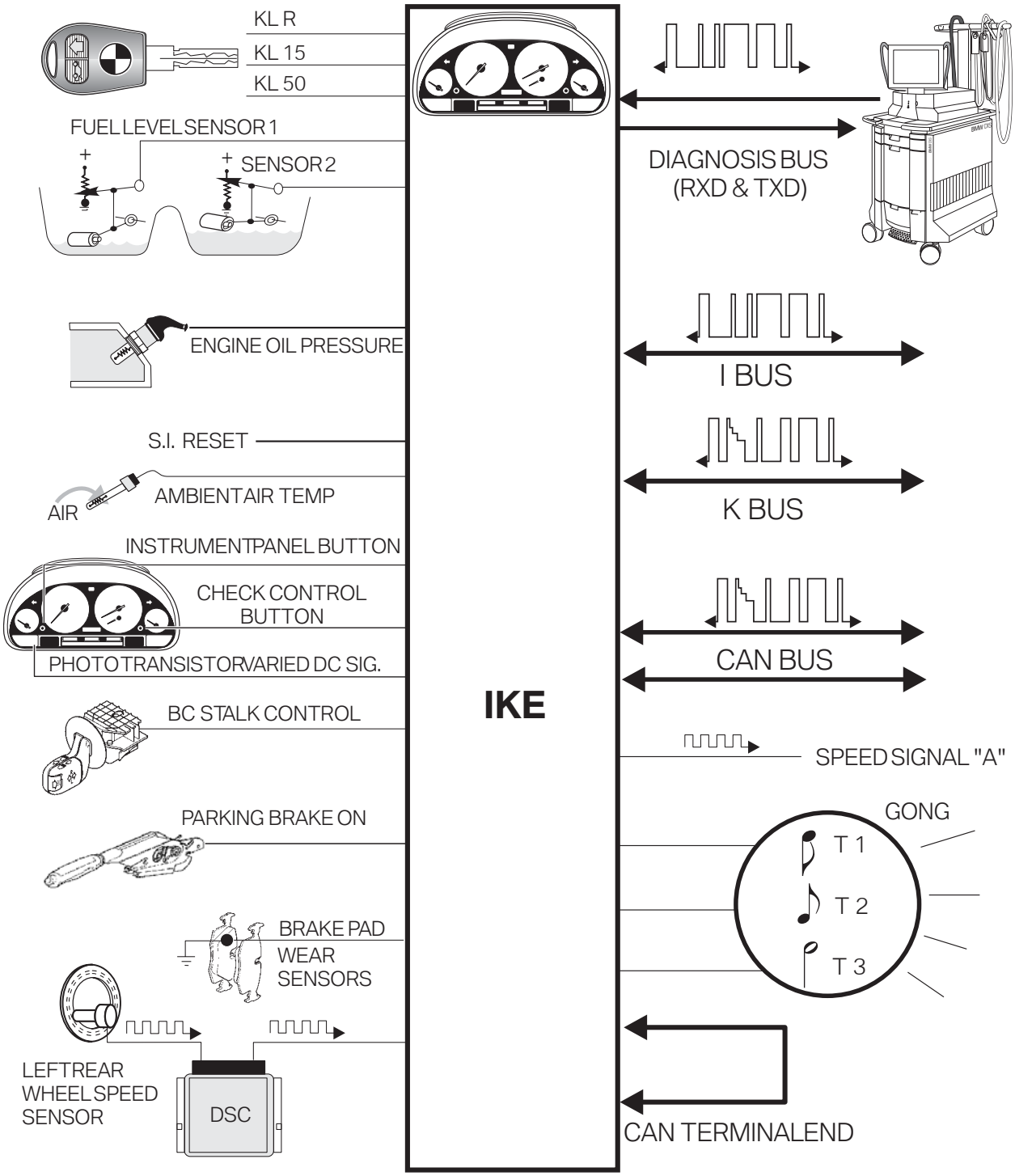
The fuel economy indicator returns to its starting point when road speed is reduced to 5 mph and doesn't move again until road speed is above 8 mph.

Certain indicator/warning lights are illuminated momentarily when KL15 is switched on as a pre-drive check. The indicators will switch off after 2 seconds or within 1 second after the engine starts.

E38 IKE I-P-O Chart (as introduced to 9/97)



E38 IKE I-P-O Chart (from to 9/97)

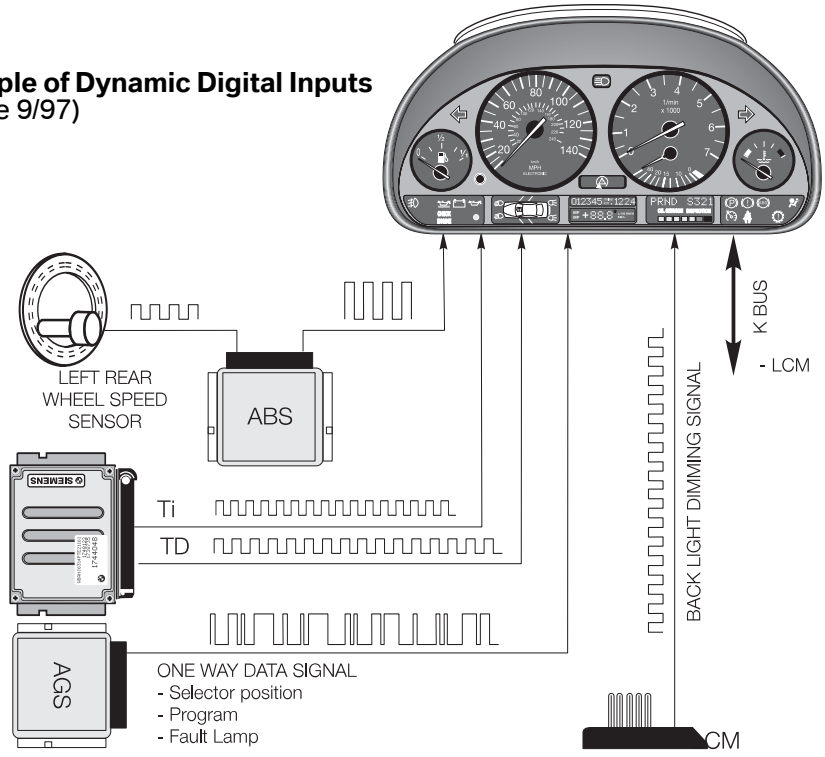


Principle of Operation

Information is received and processed by the IKE. This information (data) is sent to the cluster via the following types of inputs:

- Dynamic digital inputs - which consist of signals with a variable duty cycle or frequency.
- Digital inputs - which are on/off type signals. These are usually ground inputs from control units used to activate warning lamps.
- Analog inputs - which are variable voltage signals. Examples of analog signals battery voltage, fuel tank sending units and temperature sensors.
- Bus signals - Such as I, K, D and CAN-Bus. The CAN-Bus replaced some of the above signal inputs from 9/97.

Example of Dynamic Digital Inputs
(before 9/97)



Dynamic Digital Inputs

Distance Signal (Road Speed)

Up to 9/97 - This information is supplied to the IKE by the ABS/ASC+T or DSC control module with a square-wave signal. Pulses from the left-rear wheel speed hall sensor are used to produce this dynamic digital signal. The IKE processes this for the cluster display and provides a speed signal output on the I / K-Busses.

From 9/97 - The left rear wheel speed signal is sent by the DSC module to the IKE via the CAN-Bus.

Engine Speed Signal
Up to 9/97 - The TD signal is produced by the DME and sent to the IKE. Excessive engine speed events are stored in the IKE and can be read out through DIS. Engine speed is transmitted over the I/K-Buses.

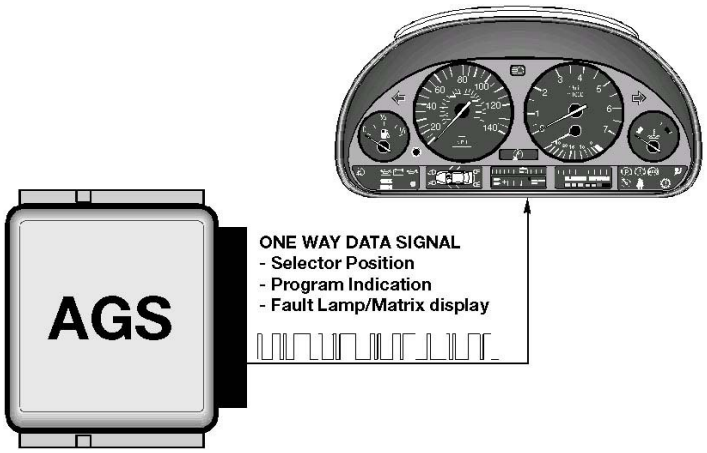
From 9/97 - The TD signal is produced by the DME and sent to the IKE via the CAN-Bus.

Injection Signal
Up to 9/97 - The DME supplies the signal (ti) via a dedicated signal line. The IKE processes this signal for for fuel consumption evaluation.

From 9/97 - The DME send the ti signal to the IKE via the CAN-Bus.

Note: On vehicles from 9/97 the wiring for the ti and TD signal may still be present in the wiring harness but the IKE is programmed to only accept the signals from the CAN-Bus.

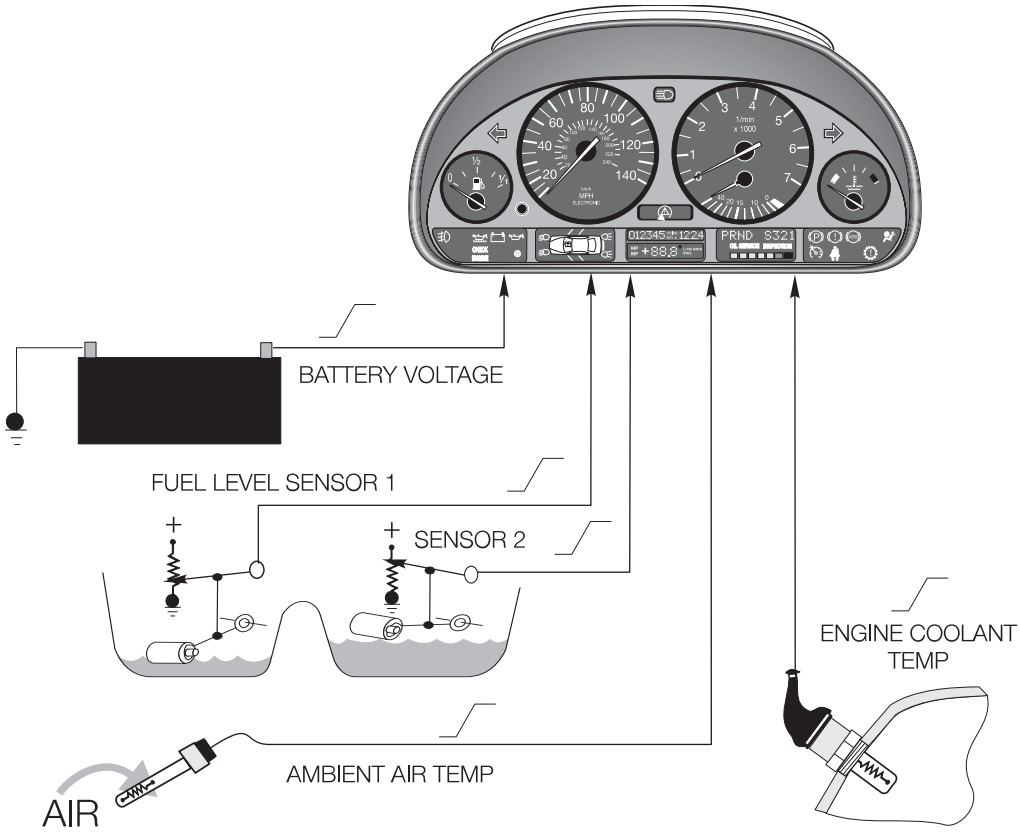
Transmission Interface
Up to 9/97 - This single-wire is a serial one-way interface that provides the IKE with selector lever position, driving program and the fault message. This information is also sent to other control units over the I/K-Buses.



From 9/97 - The IKE receives the selector lever position, driving program and the fault message from the CAN-Bus.

Dimmer Signal
This is a pulse-width modulated signal from terminal 58, of the Lamp Control Module. It is used to control back lighting of instruments and the LCD and is also transmitted to the I/K-Buses.

Analog Input Signals



Battery Voltage
The system voltage is also monitored by the IKE and sets a fault if it exceeds 16 volts.

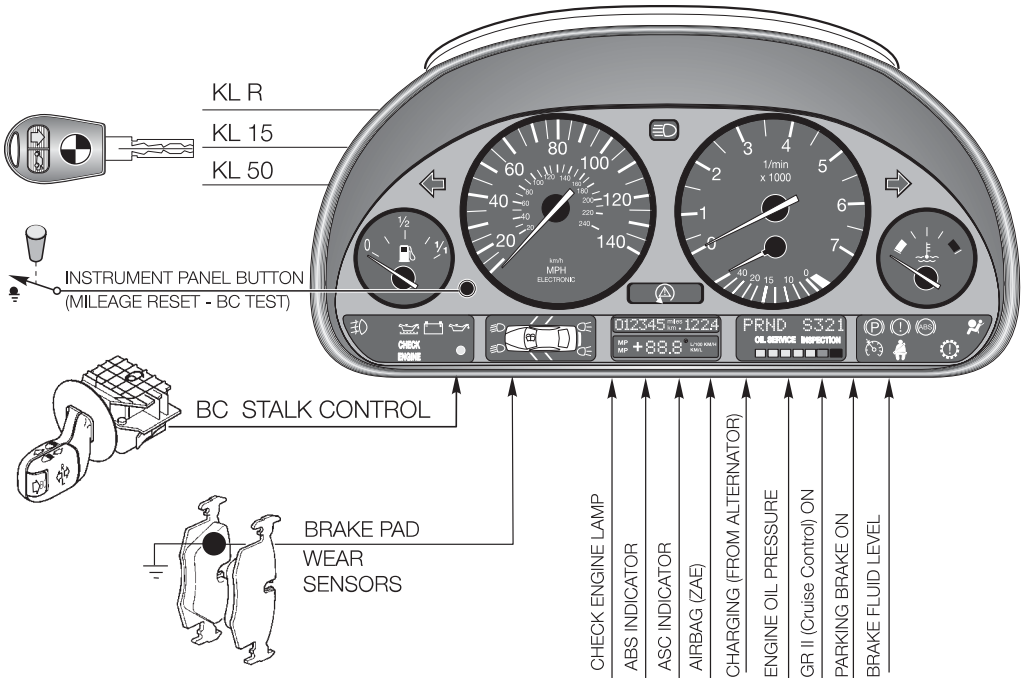
Fuel Tank Level
Two lever action sensors are wired in parallel to the IKE. The two variable resistor inputs are processed by the IKE and used to operate the fuel gauge. The low level contact has been eliminated. Therefore, the reserve light is controlled by the IKE from the sensor inputs.

Photo Transistor
A variable voltage signal, that is dependent on ambient light, is used for back lighting of the LC display.

Coolant Temperature
A NTC sensor is used by the IKE to measure coolant temperature. The CCM also receives this information over the I-BUS.

Outside Temperature Sensor
A NTC sensor is used by the IKE to measure outside temperature for display in the cluster. Other systems that require outside temperature receive this information on the I/K Buses.

Digital Input Signals



Steering Column Switch
As in previous systems, this switch is used to call up BC functions into the cluster matrix.

Brake Pad Wear Sensors
The same system that has been used in earlier models is carried over into the E38.

Oil Pressure Switch
This status is transmitted to the CCM over the I-BUS. The CCM compares the switch status with engine speed to evaluate oil pressure. IKE can store faults with the oil pressure switch and circuit.

Parking Brake Switch
Switch status is transmitted to the CCM for evaluation.

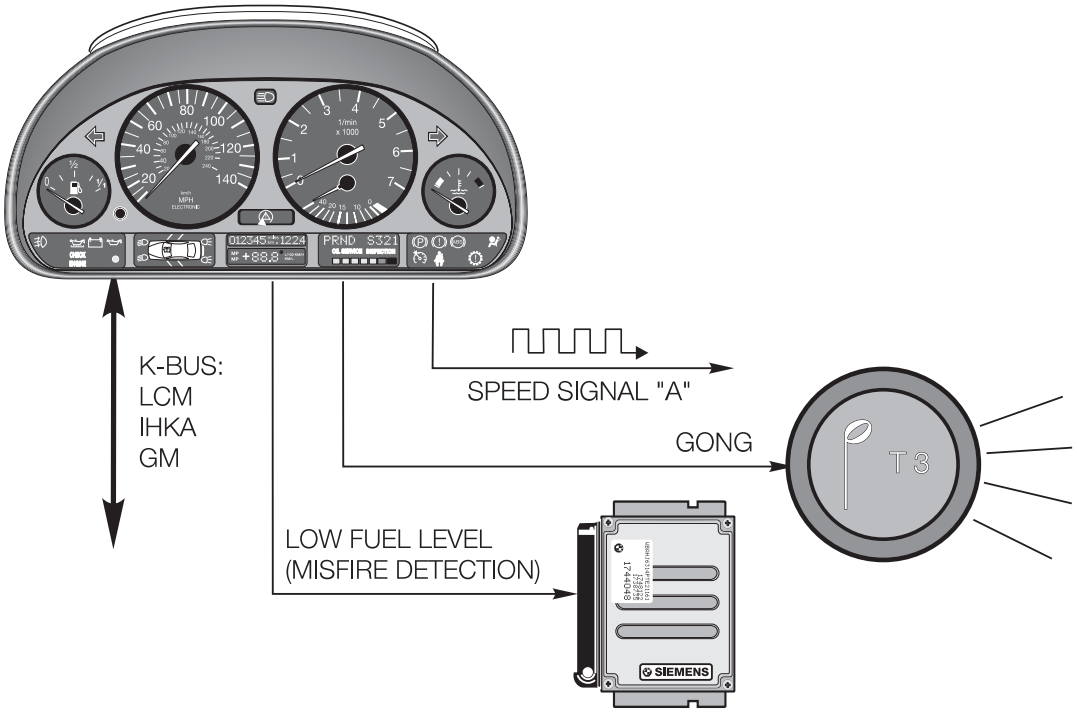
Trip Odometer Reset
The left button on the cluster is used to reset the trip mileage if the key is on and display mileage if the key is off.

Power Supply
The normal power-up and KL 50 inputs to the IKE processor:

- Terminal R
- Terminal 15
- Terminal 50

Various functions are dependent on the ignition switch positions.

Output Signals



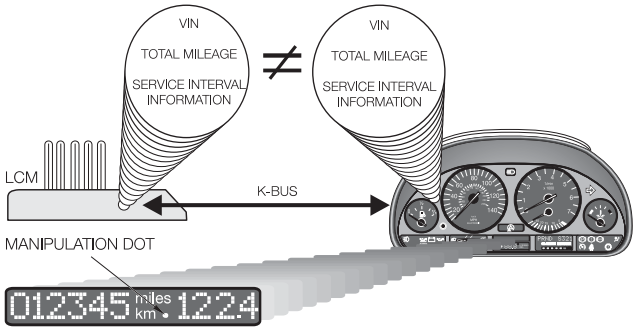
Speed Signal “A” - The vehicle speed is made available to control modules that require a precise speed value. The ABS/ASC+T wheel speed input is reduced by a factor of 5:1 to produce a speed signal “A” that these control modules can process as an input.

Gong Outputs T1, T2, T3 - the gong outputs are the same as E32.

- **T1** - Activates memo (hourly reminder).
- **T2** - Activates the tone for the freeze warning.
- **T3** - Activates the tone for check control functions.
- **T1-T2** - Activated simultaneously produces the tone for code and limit functions.

Redundant Data Storage

In previous models, total odometer mileage ad service interval data was stored on on a coding plug. With the introduction of the E38, electronic data is now stored redundantly in the IKE and LM (LCM). A coding plug is no longer necessary. due to the redundant storage.



This specific information is:

- Vehicle ID number
- Total mileage
- Service Interval information

To guard against the loss of specific vehicle information, it is stored in both the IKE and the lamp module (LCM).

This data is compared each time KL15 is switched on. If the data check reveals a mismatch, the manipulation DOT is illuminated.

Because of this redundant storage feature, the following points must be noted:

1. If the vehicle ID number is not the same in both modules, the manipulation DOT is activated and there is no data exchange between the IKE and LCM. All functions of both modules will continue to work (car can be test driven).
2. Data is only accepted from the LCM by the IKE if the ID number is the same and the IKE is at 0 miles.
3. The vehicle ID number is input into a module by way of the DIS tester and only accepted if the mileage recorder in the module is at 0 miles.
4. The LCM mileage data can only be over written with a higher mileage and is updated every 60 miles (100 km).
5. If the distance differs by more than 120 miles (200 km) and the ID numbers are the same, the IKE stores a data transfer fault.
6. If the I-Bus link to the LCM faults, the IKE stores this fault and continues to record the mileage driven.The condition that controls the redundant date exchange and allows only new components to be used as replacement.

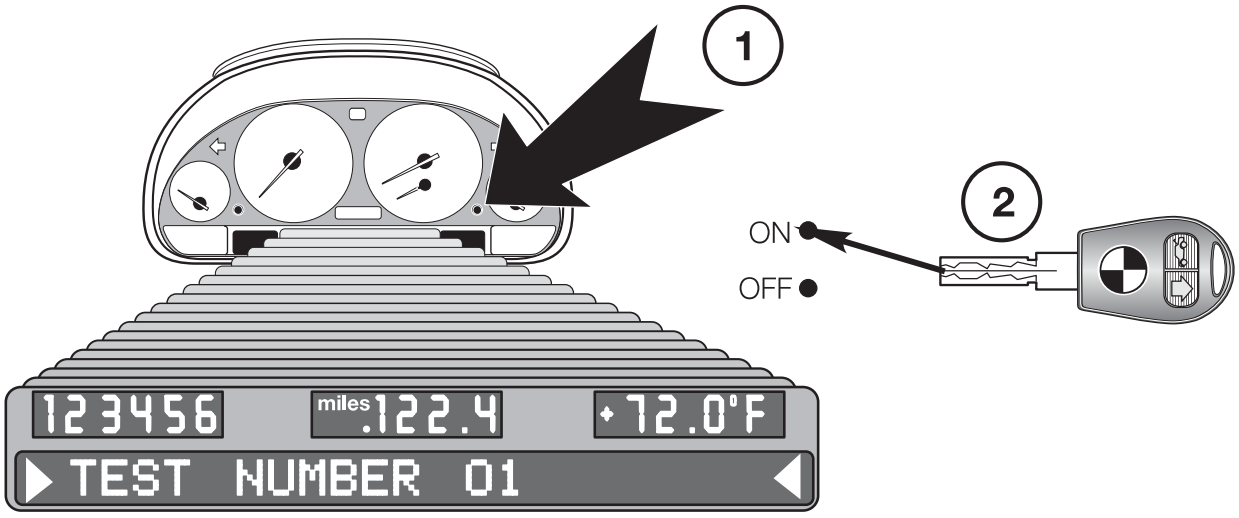
If the IKE from another car is used for testing purposes, test driving the car should be avoided if possible. If the vehicle is test driven, the IKE will record mileage and this mileage will be added to total mileage of the original car.

Note: When the IKE and LCM require replacement, do not replace at the same time. Perform coding and data transfer procedures after replacing each of the components individually. Failure to do this will result in an odometer reading of 0 miles.

BC Test Functions (IKE E38, E39, E53)

The BC test functions are used to check inputs, outputs and functions of the IKE. There are 21 possible test steps. With the exception of Test #1,, #2, and #19, all other tests are locked but can be released through test #19.

The test functions are displayed in the instrument cluster. Test number 01 is called up by pressing the CC button for 10 sec. The same activation can be initiated by pressing and holding the CC button while switching on the ignition.



Each time the CC button is pressed, the next test number is displayed.

After selecting a test number, the information from the test is posted by pressing the trip odometer reset button. Several tests have sub-functions which are called up by pressing the reset button while in the test.

Unlocking test functions:

- Call up test #19 - This is automatically done if attempting to enter a locked test
- Using the trip meter reset button enter by pressing the sum of the last 5 digits of the chassis number, example: VIN GB11111, - 1+1+1+1+1 = 5, press the reset button 5 times.
- Confirm entry by pressing the CC button.

The test function can be cancelled by switching the ignition off or pressing the CC button for approximately 2 seconds.

Test No. 01

The IKE supplies the following data, which appears on the 20 digit cluster matrix display:

- Vehicle Identification number = FGSTNR: GB11111
- K value = K: 4739
- BMW part number: Bmwtnr. 13809873
- Encoding, diagnosis and bus index: CI: 01 Di: 01 bi:01
- IKE production date: dat: 52/94
- HW/SW number: hw: 40sw:80
- Motor: zyl:8 m:6 s:400
- ROM Date: ROM; 23.08.96

Test No. 02

The following displays and instruments are activated (system test):

- Speedometer, tachometer, coolant temp gauge, fuel gauge.
- LC displays (segment test)
- Indicators and Warning Lights

This test can only be called up with the vehicle at a standstill, engine turned off, with KL R or 15 switched on.

Test No. 03

The following SI data can be displayed:

- SI km since last reset: si km: 1250
- SI automatic transmission kilometers: SI-GETR - km 23300

Test No. 04

Momentary Fuel Consumption is displayed:

- VBR: 0.0 L100km

  VBR: 0.0 l/h

Test No. 05

This function shows the range calculation data:

- Range at measured fuel consumption: RW-vbr: 19.5 l/100 km

Test No. 06

In this function, the fuel tank volume for the right and left half of the fuel tank and the current total tank volume are shown in the Instrument Cluster matrix display.

This enables the function of the float level sensors to be checked.

Display: tnk 29.5/34.2/63.7L

TNKANZ 60.2L PHASE 1

The first numerical value in line 1 shows the contents of the left half of the fuel tank, the second, the volume of the right half of the tank. The third value is the current total value. If a level sensor is defective, it's value reverts to 0.

Line 2 shows the current average value (displayed value) for the contents of the fuel tank. The numerical value after the word phase refers to the valid computed number.

Phase 1: Regular computing method by way of sensors (both sensors OK).

Phase 2: Calculation in progress from TKVA signal (sensor faulted)

Phase 3: Fuel tank contents cannot be computed, fuel gauge reads 0 (at least one sensor is faulted).

Test No. 07

Momentary coolant temperature. ktmp: 076°C

Momentary engine speed: N:5238 u/min

Test No. 08

Momentary Road Speed V: 085 KM/H

Test No. 09

Battery voltage (terminal 30) Ub: 12.5 v

Test No. 10

Preset national market codes list. The number is encoded in the IKE with the central code key

Display: usa 02

Test No. 11

The unit code is entered in the EEPROM by the DIS after IKE has been installed and can be read out by means of test function 11.

Test No. 12

This test function shows the data for computing the vehicle's estimated time of arrival.

- Average speed for calculating arrival time: vank: 029.7 km/h
- Current arrival time: ank: 13.04

Test No. 13

This test function enables the gong to be tested, Display: gong?

- After confirming by pressing the trip odometer reset button, the four audible warning signals are triggered off once in succession.
- Gong T1 (Memo signal) 2.0s
- Gong T2 (Outside temperature) 1.5 s.
- Gongs T1 and T2 (LIMIT/CODE warning) 1.5 s
- Gong T3 (Check Control Gong)

Test No. 14

This function shows the contents of the fault memory in a hexadecimal code.

Display: DIAG: D7 81 033

Test No. 15

Not assigned to any test function.

Test No. 19

Procedure for unlocking the BC test functions.

Test No. 20

BC consumption value correction factor. This test adjusts the correction factor for the consumption value displayed in the MID. The production line installed value is 1000. The value ranges from 750 to 1250.

To adjust the correction factor press the trip meter reset button once for a reduction of 1. For each press of the reset button the value decreases by 1 until it reaches 750. After 750 the number will reset to 1250 and begin to count down again.

To accept the set correction factor press the CC button.

The consumption correction factor (VK) is calculated from the actual amount of consumed fuel (VBR IST) and the displayed value (VBR ANZ):

VK = (Actual MPG / Displayed MPG) X 1000.

Test No. 21

This function resets the software at the IKE. This reset is necessary after replacing for example one of the fuel tank level sensors. Otherwise the damping function in the software will prevent the actual value from being shown only after a long time duration.

Display: reset ?

If the test is terminated without a software reset, the ignition switch must be turned back to “0” or the CC button pressed.

Check Control

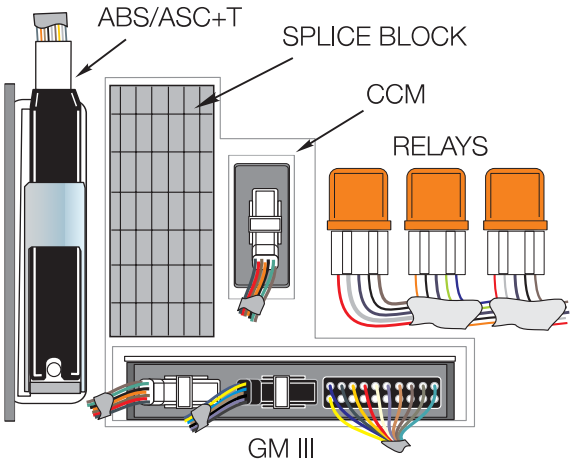
When the check control system was introduced on the E38, the Check Control Module (CCM) was a self-contained unit up until 9/95 production. E38 models from 9/95 production used a check control module which was integrated in the LCM.

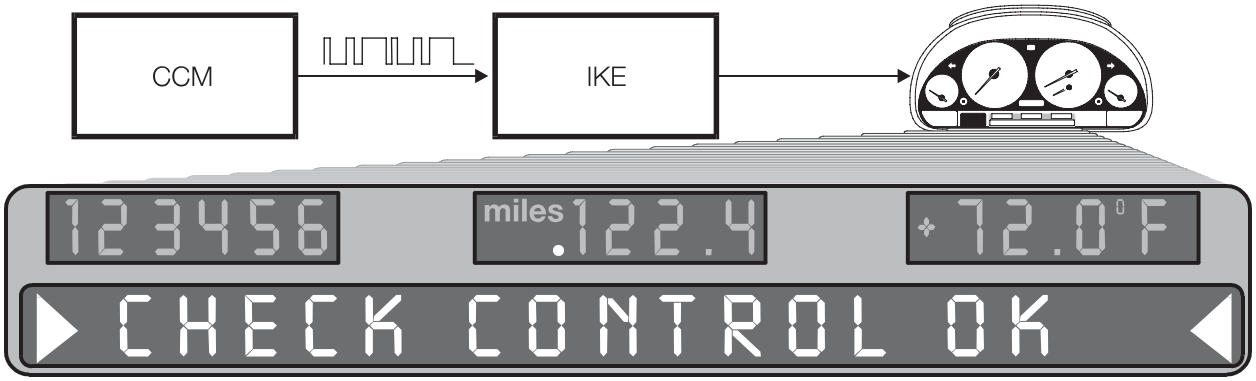
The E39 and E53 vehicles used the integrated CCM from the start of production.

The early version CCM is located in the electrical carrier in front of the glove box.

This module collects and evaluates all check control data, including messages from the Lamp Control Module (LM or LCM).

When the driver needs to be informed of a problem, the CCM signals the IKE over the I-BUS. The IKE will then post the message in the instrument cluster matrix display.



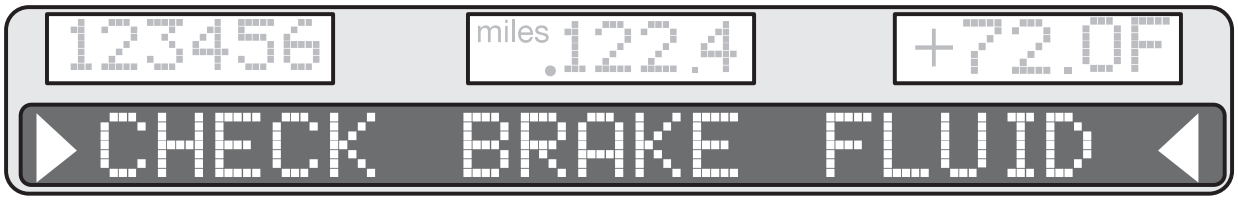


The text and operation of the E38 check control has been changed to improve message interpretation and reliability, for example:

- Gong Operation
  - Pre-E38 - Gong with every new display
  - E38 - Only activated for first display in group
  - Advantage: Reduce driver's irritation.
- Display
  - Pre-E38 - "Owner's Handbook" used repeatedly
  - E38 - "Owner's Handbook" phrase deleted. Actual text for situation with recommended action.
  - Advantage: Driver can assess situation without having to refer to the Owner's Manual.

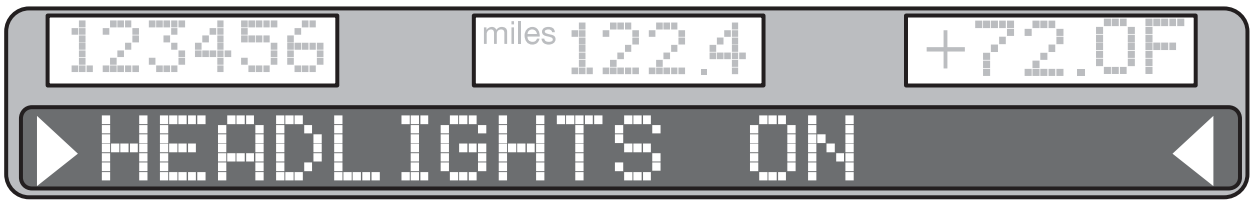
Check Control Priority Groups
All the warning messages fall into one of four priority groups.

Priority Group P1
Faults that directly affect the safety or operation of the car and the drive should be addressed immediately. The text is displayed with a flashing arrow on the right and left sides.

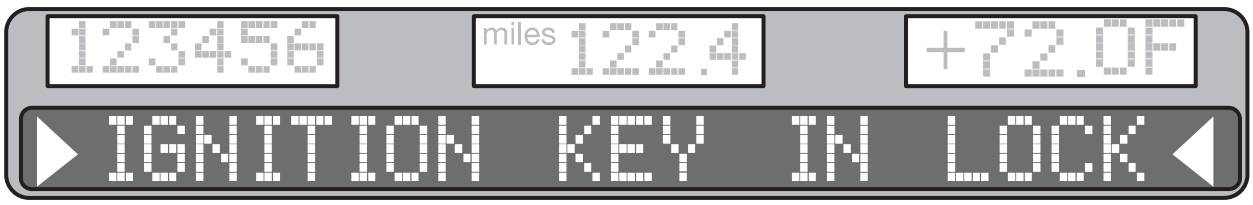


Priority Group P2
Faults that do not affect vehicle's safety or operation directly and the driver need not respond to immediately. These messages are displayed only once when the fault occurs and have to be called up again with the CC button.

Priority Group P3
These faults are shown when the key is turned on before a trip. The faults in P3 are mainly fluid levels which are not assigned to P2. The lights on reminder is a Priority 3 item. With the key in position 0 with the light switch On initiates this reminder.



Special Warnings
These are top priority messages and won't be overridden when displayed. Seat belt/ignition key in lock with door open are some of these messages.



When the key is switched off, all registered check control faults are displayed.The language of the check control messages is set with the central coding key..

CC Display Procedures

Special Displays
These messages will overwrite all other displays. If more than one special display request is received by the CCM, the one with the highest priority will be delivered.

P1 Group
P1 displays remain posted as long as the fault is present. If several P1 warnings have been received by the CCM, they are displayed one after another in 3 second intervals.

P2 and P3 Groups
The messages in both groups are displayed when KL15 is switched on for a maximum of twenty three (23) seconds and P3 messages are not displayed after the trip is started. P2 and P3 warning that have been registered by the CCM can be recalled during the trip by pressing the CC button.

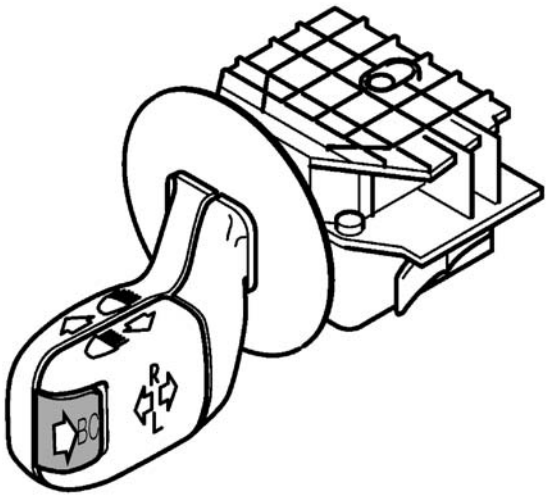
Reminder Symbol "> < "
The "+" symbol is no longer used. If more than one P1 check control message is present, the reminder symbol "> < " is illuminated permanently. If a P2 or P3 message is extinguished, the reminder symbol informs the driver that a CC message has been posted. The symbol will flash when a new P1 warning is recognized.

CC Button
Check control messages can be recalled, for up to 3 minutes, after the ignition is switched off using the CC button.

The highest priority message is displayed first with following messages in a priority descending order. After the lowest message has been displayed, pressing the CC button will clear the matrix.

"Check Control OK" is posted when the CC button is pressed and there are no warning message present.

Steering Column Switch (LSS)
Pressing the steering column switch will clear the matrix display if low priority messages are being posted. This will allow the display to be utilized for other information.



Gong
The warning gong is activated by the IKE when the CCM sends the proper data over the I Bus. The gong is activated only when higher priority warnings are posted.

Check Control Priority Chart

CCM DISPLAY	GONG	PRTY	SCOPE OF MONITOR
OPERATING CONDITIONS			
Release Parking Brake		P1	Warning displayed above 3 MPH
Door open with ignition key in position KL 15		P2	Warning displayed when a door is open or opened above 3 MPH.
Trunk Open		P2	Warning displayed above 3 MPH when trunk opens or was left open prior to pulling away. Displayed once only.
Stop! Engine oil pressure		P1	Warning displayed oil pressure has fallen below safe level.
Coolant Temperature		P1	Warning displayed when coolant rises above maximum temperature
Check Brake Lights Check low-beam headlights Check high-beam headlights Check parking lights Check front fog lights Check license plate lights		P2	The LM monitors certain vehicle lights and circuits. When a fault is detected the CCM is notified to post a display.
Check brake pads		P2	Warning issued when brake pad wear limit is reached.
Lights on?		P3	Warning displayed when key is in position 0 if driver's door is opened with light switch on.
Ignition key in lock		S	Warning is displayed when key is left in ignition switch in position R or 0.
Please Fasten Seatbelt		S	Warning is displayed for a 6 second period after "Ignition on" with seatbelt fastened or not. If seatbelt is fastened the intermittant gong is switched off.
Remote Battery		S	When remote key battery voltage drops below 4.5 volts
FLUID LEVELS			
Check Brake Fluid		P1	Warning is displayed when brake fluid is too low.
Check engine oil level		P2	Warning is displayed when the engine oil level is too low. The E38 is equipped with a new electronic oil level sensor. (see E38 Complete Vehicle for function and operational description).
Check coolant level		P2	Warning is displayed when coolant level is too low. The warning is only posted when the ignition key is first turned on.
Add washer fluid		P2	Warning is displayed when washer fluid level is low. This warning is displayed at any time the level becomes low to provide an early warning
NOTE: The fluid level warnings are monitored in 25 second intervals. This time interval prevents false displays from occuring due to bumpy roads, fluid sloshing, etc.			
CONTROL SYSTEM FAULT DISPLAYS			
Emergency transmission operating program		P2	If a fault occurs in the AGS control system Check control displays the message. The message is orriginated from the AGS CM to IKE over a one way serial data line. From there IKE notifies the CCM over the I Bus.
EEPROM IKE		S	When IKE and LM data differ (for testing purposes).

Classroom Exercise - Review Questions

1. The IKE provides a “Gateway” between which bus systems?

2. What is meant by the integrated IKE?

3. What is the “one way” data signal?

4. How are the fuel tank sensors connected to the instrument cluster? How does this differ from previous models (E36,E34 etc.)

Classroom Exercise - Review Questions

5. What is the difference between the CCM and LCM?

6. What type of check control messages are considered priority 1?

7. Why should the IKE and LCM NOT be replaced at the same time?

8. What is the “correction factor” used for?